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In-Space Propulsion Engine Architecture Based on Sublimation of Planetary Resources: From Exploration Robots to NEO Mitigation

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Abstract

Volatile solids occur naturally on most planetary bodies including the Moon, Mars, asteroids and comets. Examples of recent discoveries include water ice, frozen carbon dioxide and hydrocarbons. The ability to utilize readily available resources for in-space propulsion and for powering surface systems during a planetary mission will help minimize the overall cost and extend the operational life of a mission. The utilization of volatile solids to achieve these goals is attractive for its simplicity. We have investigated the potential of subliming in situ volatiles and silicate minerals to power propulsion engines for a wide range of in-space applications where environmental conditions are favorable. This paper addresses the practicality of using planetary solid volatiles as a power source for propulsion and surface systems by presenting results of modeling involving thermodynamic and physical mechanics calculations, and laboratory testing to measure the thrust obtained from a volatile solid engine (VSE). Applications of a VSE for planetary exploration are discussed as a means for propulsion and for mechanical actuators and surface mobility platforms.